**POLYCYCLIC AROMATIC HYDROCARBONS IN METEORITES: ALLAN HILLS 84001, MURCHISON, AND ORGUEIL.** T. Stephan, C. H. Heiss, D. Rost and E. K. Jessberger, Institut für Planetologie/Interdisciplinary Center for Electron Microscopy and Microanalysis, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, D-48149 Münster, Germany, stephan@uni-muenster.de.

**Introduction:** The discovery of polycyclic aromatic hydrocarbons (PAHs) in the Martian meteorite ALH 84001 led to a controversial discussion about their origin and their potential role as a biomarker for past life on Mars [1–8]. In principle PAHs can derive from biogenic as well as non-biogenic sources. On Earth, PAHs originate mainly from anthropogenic emission caused by the combustion of fossil fuels and other, natural biogenic sources [9, 10]. PAHs found in ordinary and carbonaceous chondrites [11], interplanetary dust [12], and circumstellar graphite grains [13] can be attributed to a non-biogenic origin.

To continue our investigation of PAHs in ALH 84001 using TOF-SIMS (time-of-flight secondary ion mass spectrometry) [5, 6, 8] we searched for PAHs in two carbonaceous chondrites, Murchison (CM) and Orgueil (CI). It was hoped that a comparison of the respective secondary ion mass spectra with TOF-SIMS spectra obtained from ALH 84001 samples can help to enlighten the origin of PAHs in this Martian meteorite.

**Samples and Analytical Technique:** Freshly crushed samples of Murchison and Orgueil were pressed in gold and indium foils, respectively. Together with blank Au and In foils these samples were analyzed using TOF-SIMS.

In TOF-SIMS, a time-of-flight mass spectrometer is used for the analysis of positive or negative secondary ions sputtered from the uppermost monolayers during primary ion bombardment. Besides atomic ions also molecules can survive the sputtering process, at least as characteristic fragments. Using a fine focused gallium liquid metal primary ion source, a simultaneous measurement of the lateral distribution for all secondary ion species with one polarity is possible with a lateral resolution of ~0.2 µm. High mass resolution allows to separate atomic ions from hydrocarbons at same nominal masses and reliable peak assignments can often be made due to the accuracy of the mass determination [14].

**Results:** TOF-SIMS mass spectra for Murchison and Orgueil samples on Au foil are shown in Fig. 1. Mass spectra obtained from samples pressed in In foil look similar. A mass spectrum from a polished thin section of ALH 84001 [5] is given for comparison. All spectra show similar relative abundances of PAHs. Although the high purity metal foils were cleaned beforehand with pure ethanol, organic surface contamination was found. Since the information depth in TOF-SIMS is of the order of a few atomic monolayers and since we limited our analysis to regions totally covered by meteoritic material, this contamination had only little influence on the measurements of Murchison and Orgueil. Nevertheless, we found a so far unexplained peak at 159 amu nominal mass predominately on the Au blank as well as both meteorite samples pressed in Au (Fig. 1).

Since PAHs were not found on Au or In, contamination with terrestrial PAHs during our sample preparation can be excluded. A general contamination with terrestrial PAHs in our laboratory can also be ruled out [5, 6, 8].

**Discussion:** TOF-SIMS spectra of PAHs from the carbonaceous chondrites Murchison and Orgueil resemble remarkably well those obtained from ALH 84001. Characteristic fragmentation occurs during the sputtering process as observed earlier [8]. The spectra in Fig. 1 are relatively simple and don't show any indication for aromatic heterocycles or major alkylation [2]. Since relative abundances of different PAHs are essentially the same for all three meteorites, a similar, non-biogenic origin can be deduced. For biogenic PAHs we would expect higher degrees of alkylation and the presence of aromatic heterocycles like observed in terrestrial samples [9, 10].

**References:** [1] Thomas K. L. et al. (1995) *LPS XXVI*, 1409–1410. [2] McKay D. S. et al. (1996) *Science, 273*, 491–504. [3] Becker L. et al. (1997) *GCA, 61*, 475–481. [4] Jull. A. J. T. et al. (1998) *Science, 279*, 366–369. [5] Stephan T. et al. (1998) *LPS XXIX*, #1263. [6] Stephan T. et al. (1998) *Meteoritics & Planet. Sci., 33*, A149–A150. [7] Clemett S. J. et al (1998) *Faraday Discussions (Royal Soc. Chem.), 109*, 417–436. [8] Stephan T. et al. (1998) in *Workshop on the Issue Martian Meteorites: Where Do We Stand and Where Are We Going?* pp. 50–51. LPI Contrib. No. 956. [9] Wakeham S. G. et al. (1980) *GCA, 44*, 403–413. [10] Wakeham S. G. et al. (1980) *GCA, 44*, 415–429. [11] Clemett S. J. et al. (1992) *LPS XXIII*, 233–234. [12] Clemett S. J. et al. (1993) *Science, 262*, 721–725. [13] Clemett S. J. et al. (1996) *LPS XXVII*, 229–230. [14] Niehuis E. (1990) in *Secondary Ion Mass Spectrometry, Proc. SIMS VII*, pp. 299–304. Wiley, Chichester.

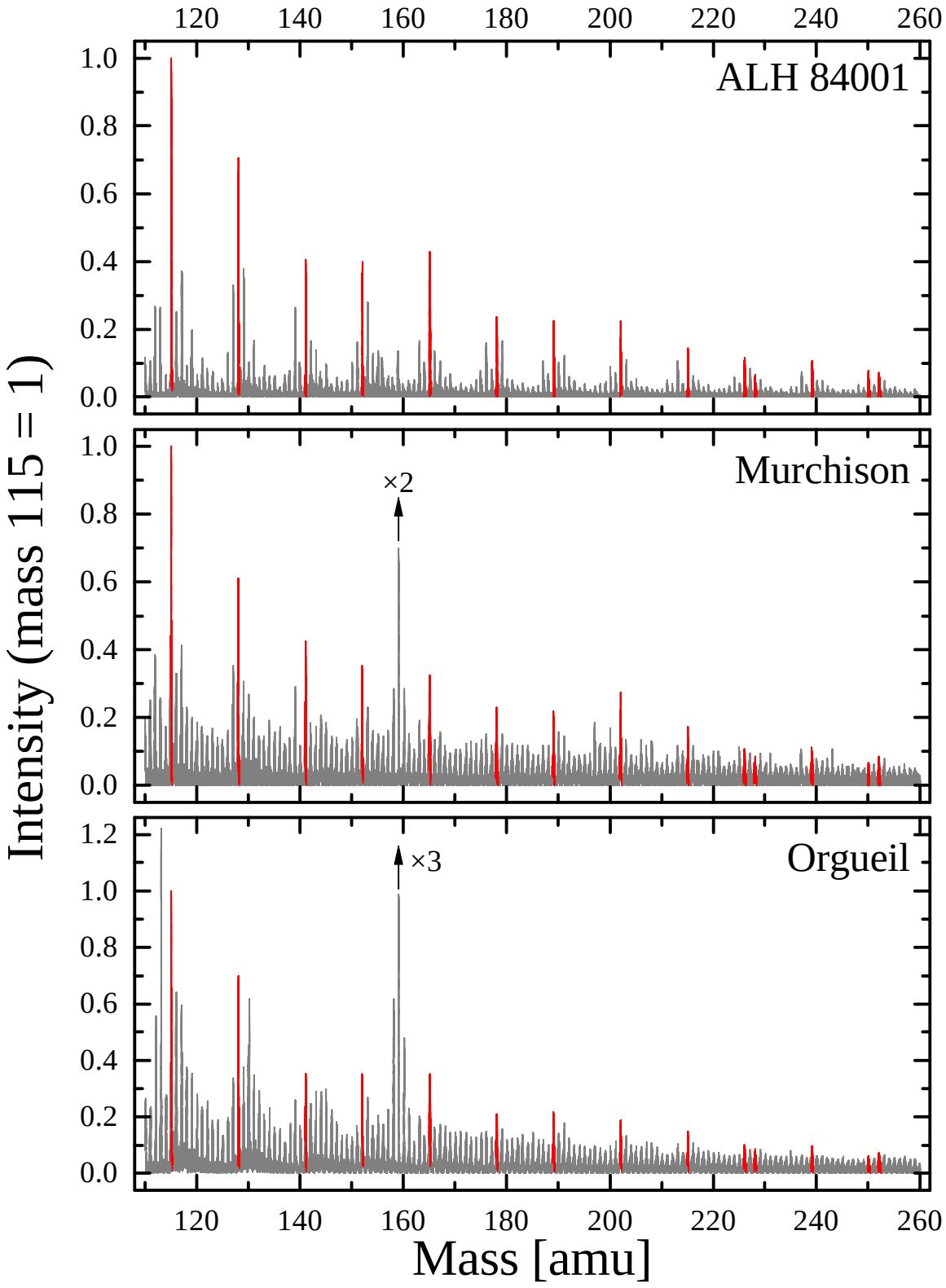


Fig 1: Comparison of TOF-SIMS spectra of mass range 110–260 amu for ALH 84001 [5], Murchison, and Orgueil show similar intensities of typical PAH masses (shown in red) relative to the most intense PAH peak at 115.05 amu ($C_9H_7^+$). The peaks at 159 amu in the mass spectra of Murchison and Orgueil result probably from laboratory contamination of the underlying Au foil. Their intensity is lowered by the factors mentioned above the peaks.